STOEL
RIVES
LLP
ATTORNEYS AT LAW

900 S.W. Fifth Avenue, Suite 2600
Portland, Oregon 97204
main 503.224.3380
fax 503.220.2480
www.stoel.com

THOMAS R. WOOD
Direct (503) 294-9396
trwood@stoel.com

October 16, 2006

BY EMAIL AND BY MAIL

Amy Zimpfer
Associate Director, Air Division
U.S. Environmental Protection Agency
75 Hawthorne Street
San Francisco, CA 94105

Re: Cabrillo Port Project
Response to Information Request

Dear Amy:

Renee Klimczak is in receipt of your October 2, 2006 request that BHP Billiton LNG International Inc. ("BHP") respond to four questions regarding its Cabrillo Port project. Renee requested that I draft this letter in response. We have organized the letter in the order of your questions.

Question 1: *EPA requests that BHP provide the Agency with a comprehensive list of changes and updates that have been made to the Project since the submittal of the December 2005 application.*

Answer 1: BHP recognizes that it has made improvements to the Cabrillo Port project description and emissions inventory since it submitted its December 2005 application. BHP has sought to be proactive in responding to questions and comments about the project. Therefore, when practical enhancements have been suggested, the company has moved ahead to incorporate them into the project and the project description. With any new type of project this iterative process and receptiveness to improvements should be encouraged. However, we recognize that it adds to the work for the permitting agency.

The following is a summary of the most current emissions inventory. A copy of the most current emissions inventory is included as an attachment to this letter. In order to clarify that this is the most current inventory, we have identified each sheet in the lower right-hand corner with a revision date. The most recent revision date is October 6, 2006

Stationary Source (FSRU)								
Qty.	Description	Rating (each)	Fuel	Annual Emissions, tons per year				
				NO_X	ROC	CO	SO_2	PM_{10}
3	Wartsila 9L50DF Main Generators	8250 KW	Gas / CA Diesel	12.2	24.5	20.8	0.08	8.1
1	Wartsila 9L50DF Backup Generator	8250 KW	Gas / CA Diesel	1.9	0.3	0.2	0.01	0.1
8	Sub-X Submerged Combustion Vaporizers	115 mmBTU/hr	Gas Only	48.9	3.5	148.9	0.33	3.8
4	Emergency Fire Pump / Generator	600 / 4200 KW	CA Diesel	3.0	0.4	1.9	0.00	0.1
3	Freefall Lifeboat	56 KW	CA Diesel	0.0	0.0	0.0	0.00	0.0
1	LNG Carrier (Pumping Only)	3733 KW	Gas/CA Diesel	9.4	2.7	6.6	-	0.4
1	Diesel Fuel Storage Tank	145,000 gallons	CA Diesel	-	0.03	-	-	-
1	Inert Gas Generator	67.17 mmBTU/hr	Gas only	0.2	0.00	0.01	0.00	0.00
Total Emissions - Stationary Source (FSRU)				**75.6**	**31.4**	**178.4**	**0.42**	**12.5**

Vessels in Federal Waters								
Qty.	Description	Rating (each)	Fuel	Annual Emissions, tons per year				
				NO_X	ROC	CO	SO_2	PM_{10}
2	Tug Supply Boat	15,000 BHP Mains	CA Diesel with controls	26.2	11.2	24.6	0.16	1.4
1	Crew Boat	1,500 BHP Mains	CA Diesel with controls	0.8	0.3	0.8	0.01	0.0
1	LNG Carrier	60,000 BHP Total	Gas / CA Diesel	21.1	6.1	14.9	0.01	0.9
Total Emissions - Vessel in Federal Waters				**48.1**	**17.6**	**40.3**	**0.18**	**2.3**

Vessels in District Waters								
Qty.	Description	Rating (each)	Fuel	Annual Emissions, tons per year				
				NO_X	ROC	CO	SO_2	PM_{10}
2	Tug Supply Boat	15,000 BHP Mains	CA Diesel with controls	0.22	0.09	0.21	0.00	0.01
1	Crew Boat	1,500 BHP Mains	CA Diesel with controls	0.06	0.03	0.06	0.00	0.00
Total Emissions - Vessel in District Waters				**0.28**	**0.12**	**0.27**	**0.0**	**0.01**

Below is a summary of the revisions made to the project description and emissions inventory categorized by the FSRU emissions, Federal Waters vessel emissions, and District Waters vessel emissions. Please consider this letter to be a request to amend the application to reflect each of the changes outlined below.

FSRU Summary of Revisions:

1.) LNG off-loading emissions

In response to comments, BHP removed the emissions associated with providing power to the LNG off-loading pumps from the Federal Waters emissions inventory and added them to the FSRU stationary source emissions inventory. The following assumptions were utilized in calculating these LNG off-loading emissions:

- The LNG off-loading pumps require the 4,450 kW of electricity which is provided by the carrier engines.
- The carrier engines are fueled on natural gas (1% diesel pilot fuel)
- Emissions calculations were based a 138 km^3 LNG carrier
- An annual total of 1,139 hours of operation were allocated to this off-loading activity (99 berthings per year, 8.5 hours pumping at the FSRU per berthing, and 3 hours ramp down at the FSRU per berthing)

Emission factors used for these emission calculations were derived from the March 16, 2006 Wartsila specification. In order to ensure that the emission factor is conservative and in order to allow for variations in engines and variable loads, the Wartsila emission factors were increased by a 33.3% margin for all pollutants except SO_2.

2.) Wartsila 9L50DF Main Generators

BHP received new Wartsila manufacturer specifications from Wartsila, dated March 16, 2006 (copy attached). Emission factors from that report were utilized to update the emissions from these main generators for all criteria pollutants. Criteria pollutant concentration (ppmv) levels were determined from these emission factors. SO_2 emissions did not change since they are based upon fuel sulfur content, which was not revised. This information is summarized in Table 1 below:

Table 1. Main Generator Emission Factors

Pollutant	Emission Factor (g/kW-hr)	Calculated Emission Factor (g/bhp-hr)	Emittent PPM
NO_x	0.10	0.075	7.5
ROC	0.20	0.149	43.2
CO	0.17	0.127	21.0
PM_{10}	0.0662	0.049	0.0042
CO_2	444	331	3.49 %

In the December 2005 application submittal, BHP based the main generator heat rate of 7,239 BTU/KW-hr from the Wartsila specification (0047057-S504, May 13, 2005). However, in response to comments from the South Coast AQMD, BHP corrected the SO_2 low heating value (LHV) to high heating value (HHV). This resulted in a heat rate increase of 10 %, thus increasing the heat rate from 7,239 to 7,963 BTU/KW-hr. As a result, total FSRU SO_2 emissions increased from 0.41 to 0.42 tons per year.

3.) SCV Throughput

In a letter to the USEPA dated July 6, 2006, BHP clarified that the maximum utilization of four SCVs (or the equivalent of four SCVs) is based on annual average operations. The daily natural gas export rate on an annual average basis will not exceed 800 MMscf/day. BHP anticipates that there will be times when demand is critical and the Gas Company will want higher short-term flows. On an unusually high demand day, Cabrillo Port could be called on to export as much as 1.2 Bscf/day. The revised modeling report (also submitted on July 6, 2006), reflects these anticipated short-term variations in flow. BHP's updated modeling analysis demonstrated that Cabrillo Port will not cause or contribute to an exceedance of any ambient air quality standard or increment. This revision had no impact on the FSRU annual emissions.

4.) Inert Gas Generator (IGG)

The IGG unit is a standard marine type unit for LNG carriers. It is manufactured by Moss Hamworthy and is specified for a capacity of 20,000 Nm3/hr. The IGG unit works on the principle of using combustion gases for tank inerting and decommissioning. The IGG is expected to operate 36 hours per year. The December 2005 emissions inventory failed to account for the IGG emissions. Adding these to the current emissions inventory resulted in the FSRU emissions increasing by 0.20 tons per year of NO_x, 0.10 tons per year of CO, and 137 tons per year of CO_2.

5.) General Revisions and Errata Corrections

For modeling purposes, FSRU Wartsila generator and SCV stacks were reclassified as discrete point source stacks as opposed to the previous merged stack classification. This change was in response to a request from State Land's consultant and did not affect the impacts analysis.

Appendix A of the December 2005 application, Tables FW 1 And DW 1 incorrectly identified the pilot fuel used when burning natural gas as "biodiesel". The pilot fuel has now been correctly identified as "diesel".

The diesel storage tank capacity was identified as 144,500 gallons in the text of the application, but appeared as slightly different values in the emissions inventory spreadsheets. The correct storage capacity is 144,500 gallons. The new emissions calculation spreadsheets have been revised to reflect this value consistently.

In the December 2005 application BHP states at page 2-10 that the material-handling crane will be diesel fired, while at page 3-4 it is stated that the material-handling crane will be electric. The material-handling crane will be electric.

<u>Federal Waters Summary of Revisions:</u>

1.) LNG off-loading emissions

As mentioned above in the revisions to the FSRU, emissions associated with LNG off-loading power requirements were removed from the Federal Waters emissions inventory and reallocated to the FSRU stationary source emissions inventory.

2.) LNG Carrier Emissions

BHP has revised the emissions associated with the LNG carriers including a revised activity profile, LNG carrier capacities, engine and power specifications, and the number of berthing trips. As requested by EPA, these revisions are summarized in detail in our response to Comment No. 2 below.

3.) Support Vessels: Tug/Supply Boats and Crewboats

Support vessels (tug/supply boat, crewboat) emissions were revised (a) to incorporate operation on California diesel fuel with add-on SCR and oxidation catalyst controls, (b) to include ammonia slip emissions from the vessels' SCR units, and (c) to eliminate the tug/supply boat generator and its associated emissions. In addition, support vessel trips were adjusted to accommodate the larger sizes of LNG carriers that are anticipated will be available for the Project, as follows:

- 99 tug/supply boat berthing activities per year (as the maximum).
- 52 round trips per year for the tug/supply boats to shore for supplies.
- Increased tug/supply boat activity to conduct standby/patrol activities.
- Crewboats will conduct 198 round trips per year at 7 hours per trip for operations support and patrol duties (as the maximum).

As requested by EPA, these revisions are summarized in detail in our response to Comment No. 4 below.

<u>District Waters Summary of Revisions:</u>

1.) Support Vessels: Tug/Supply Boats and Crewboats

Support vessels (tug/supply boat, crewboat) emissions were revised (a) to incorporate operation on California diesel fuel with add-on SCR and oxidation catalyst controls, (b) to include ammonia slip emissions from the vessels' SCR units, and (c) to eliminate the tug/supply boat generator and its associated emissions. In addition, support vessel trips were adjusted as follows:

- 99 tug/supply boat berthing activities per year (as the maximum).
- 52 round trips per year for the tug/supply boats to shore for supplies.
- Increased tug/supply boat activity to conduct standby/patrol activities.
- Crewboats will conduct 198 round trips per year at 7 hours per trip for operations support and patrol duties (as the maximum).

As requested by EPA, these revisions are summarized in detail in our response to Comment No. 4 below.

Question 2: *EPA requests that BHP provide a detailed description of the boiler/engine array in the carriers that will deliver LNG to the FSRU. The description should include a complete list of all boilers and engines with their specifications and an explanation of the functions each assists in during the full range of activities in the LNG delivery process (e.g., cruising, maneuvering, unloading, hoteling, etc).*

In addition, provide calculations of the emissions from each boiler or engine for each activity. The calculations should clearly indicate all emission factors, assumptions, and parameters (including but not limited to load, fuel type, and fuel specifications) used in the calculations, and the sources of such factors, assumptions, and parameters. The calculations should be accompanied by a detailed narrative discussion of the calculation methodology.

Answer 2: In response to EPA's question, BHP has set forth below a detailed description of the boiler/engine array in the carriers that will deliver LNG to the FSRU. We note that these carriers are not part of the stationary source and so this portion of the application addendum is for purely informational purposes. The only aspect of the carriers that is being characterized as part of the stationary source subject to permitting are the emissions produced by the carrier engines when generating electricity for the LNG transfer pumps.

Equipment

Newer LNG carriers feature a dual fuel electric drive configuration where multiple Wartsila Series 50DF or similar engines drive electric generators which, in turn, power either conventional shaft or "Azipod" electric propeller motors. For example, Wartsila manufactures Series 50DF engine-generators in 6, 8, and 9 cylinder "L" (in-line) arrangements and 12, 16, and 18 cylinder "V" arrangements. The multi-motor electric drive system provides excellent power management compared to conventional direct-drive shaft propulsion. A typical 33,000 kilowatt vessel with 138,000 m^3 LNG capacity may be equipped with two (2) 6L50DF and two (2) 12V50DF engine-generators. A typical 44,000 kilowatt vessel with 210,000 m^3 LNG capacity may be equipped with two (2) 6L50DF and two (2) 18V50DF engine-generators.

Tables 2, 3 and 4 show anticipated LNG carrier power plant specifications for 138,000 m^3 and 210,000 m^3 capacity vessels. The smaller carrier is "typical" of vessels currently in service, while the larger carrier is a "next generation" vessel in the planning stage, i.e., not yet built. To support the 800 mmcf/day FSRU throughput, 99 small carriers <u>or</u> 65 large carriers would be required to berth annually, although a combination of vessels would actually be used as the larger carriers come online. Worst case annual Federal Waters emissions are based on the 99 small carrier scenario since more berthings increase emissions from support vessel (tug supply, crew) activity, which more than offset slightly lower carrier emissions from fewer and more efficient large ships.

Table 2. 138,000 m^3 Capacity LNG Carrier Power Plant

138,000 m^3 Capacity LNG Carrier	**Engine Type**	**Net Output Kilowatts**	**No. of Cylinders**	**Disp. Liters**	**Activity Function**
Starboard Main Engine/Generator	Wartsila 12V50DF or equiv.	11,000	12	1,367	Cruise, Maneuver
Port Main Engine/Generator	Wartsila 12V50DF or equiv.	11,000	12	1,367	Cruise, Maneuver
Starboard Auxiliary Engine/Generator	Wartsila 6L50DF or equiv.	5,500	6	683	Berth, Offload, Hotel
Port Auxiliary Engine/Generator	Wartsila 6L50DF or equiv.	5,500	6	683	Berth, Offload, Hotel
Total Installed Engines/Generators		**33,000**	**36**	**4,100**	

Table 3. 210,000 m^3 Capacity LNG Carrier Power Plant

210,000 m^3 Capacity LNG Carrier	Engine Type	Net Output Kilowatts	No. of Cylinders	Disp. liters	Activity Function
Starboard Main Engine/Generator	Wartsila 18V50DF or equiv.	16,500	18	2,050	Cruise, Maneuver
Port Main Engine/Generator	Wartsila 18V50DF or equiv.	16,500	18	2,050	Cruise, Maneuver
Starboard Auxiliary Engine/Generator	Wartsila 6L50DF or equiv.	5,500	6	683	Berth, Offload, Hotel
Port Auxiliary Engine/Generator	Wartsila 6L50DF or equiv.	5,500	6	683	Berth, Offload, Hotel
Total Installed Engines/Generators		**44,000**	**48**	**5,466**	

Table 4. Wartsila 50DF Specifications

Wartsila 50DF Specifications	Value	Units
Bore	500	mm
Stroke	580	mm
Displacement	113.88	liters/cyl
Speed (60 Hz)	514	rpm
Heat Rate (HHV)	7963	btu/kw-hr
Thermal Efficiency	42.86	percent
Gross Output	950	kW/cyl
Net Output	916.67	kW/cyl
Conversion Efficiency	96.49	percent

Notes:
Wartsila Spec 0047057-S504, 13 May 05, corrected to HHV (110% of LHV)
40% efficiency assumed for calculations (8533 BTU/kW-hr)

For such LNG carriers calling at Cabrillo Port, several possible power combinations (steps) are shown in Tables 5 and 6 for 138,000 m^3 and 210,000 m^3 capacity vessels, respectively. In each power step, the engines are running in the upper end of their load range for high efficiency and low emission rates.

Table 5. 33,000 kW Power Scenarios

Power	Percent of Total	6L50DF	6L50DF	12V50DF	12V50DF
Scenario	**Power**	**kW**	**kW**	**kW**	**kW**
A	16.7%	5,500			
B	33.3%	5,500	5,500		
C	50.0%	5,500		11,000	
D	66.7%	5,500	5,500	11,000	
E	83.3%	5,500		11,000	11,000
F	100.0%	5,500	5,500	11,000	11,000

Table 6. 44,000 kW Power Scenarios

Power	Percent of Total	6L50DF	6L50DF	18V50DF	18V50DF
Scenario	**Power**	**kW**	**kW**	**kW**	**kW**
A	12.5%	5,500			
B	25.0%	5,500	5,500		
C	50.0%	5,500		16,500	
D	62.5%	5,500	5,500	16,500	
E	87.5%	5,500		16,500	16,500
F	100.0%	5,500	5,500	16,500	16,500

Emission Factors

Table 7 shows specified emission factors for the Wartsila 50DF engine in dual fuel mode. In dual fuel mode, 99.2% of the heat input is from the main gas fuel and 0.8% of the heat input is from the diesel pilot fuel (99%/1% by weight). Scarborough LNG (Table 8) has a HHV of 1007.6 BTU/cf (23,779 BTU/lb) and contains 1 ppmv sulfur. California ultra-low sulfur diesel has a HHV of 19,300 BTU/lb (AP-42, Table 3.3-1) and contains 15 ppmw sulfur. As shown in

Table 9, this yields a combined SO_2 emission factor of 0.0007 g/kW-hr (rounded) for dual fuel operation of the Wartsila 50DF. The Wartsila emission factors are based on source tests performed by Wartsila as part of their engine certification process. Measurement methods quoted by Wartsila are as follows:

- NO_X – EPA Method 7E (chemiluminescence)
- SO_X – ISO/CD 8178-1 (fuel sulfur content)
- CO – EPA Method 10 (GFC infrared)
- VOC – EPA Method 25A (FID) and EPA Method 18 (GC)
- PM_{10} – EPA Method 5B (train), Method 17 (in-stack), and Method 201A (front half)

In order to allow for variations in dual fuel engine types and variable loads, a 33.3% average adjustment factor is applied to the specified emission factors, except for sulfur dioxide. This assumption was made based on the judgment of BHP maritime operations staff with advice from a marine consultant.

Table 7. Wartsila 50DF Emission Factors

Wartsila 50DF Emissions	Emission Factor Reference	Spec 90% g/kW-hr	Adjustment Factor	Adjusted g/kW-hr	Adjusted g/bhp-hr
Nitrogen Oxides (as NO_2)	Wartsila Spec, 16 March 2006	1.50	1.333	2.00	1.49
Reactive Hydrocarbons (ROC) as CH_4	Wartsila Spec, 16 March 2006	0.431	1.333	0.575	0.429
Carbon Monoxide (CO)	Wartsila Spec, 16 March 2006	1.06	1.333	1.41	1.05
Sulfur Dioxide (SO_2)	99.2% gas, 0.8% CA diesel	0.0007	1.000	0.0007	0.0005
Particulates (as PM_{10})	Wartsila Spec, 16 March 2006	0.0662	1.333	0.0883	0.0658
Carbon Dioxide (CO_2)	Wartsila Report, 4 July 2003	444	1.333	592	441

Table 8. Scarborough LNG Specifications

Component Gas	Chemical Formula	Molecular Weight	HHV btu/scf	Composition mole fraction	Composition Mole Wt	HHV btu/scf	HHV btu/lb
Carbon Dioxide	CO_2	44.010			0.00000		
Nitrogen	N_2	28.013		0.002000	0.05603		
Methane	CH_4	16.043	1008.9	0.997000	15.99487	1005.83	
Ethane	C_2H_6	30.070	1767.3	0.001000	0.03007	1.77	
Propane	C_3H_8	44.097	2515.4		0.00000	0.00	
i-Butane	C_4H_{10}	58.124	3250.0		0.00000	0.00	
n-Butane	C_4H_{10}	58.124	3259.4		0.00000	0.00	
i-Pentane	C_5H_{12}	72.151	3997.0		0.00000	0.00	
n-Pentane	C_5H_{12}	72.151	4006.3		0.00000	0.00	
TOTAL				**1.00000**	**16.081**	**1007.6**	**23,779**

Table 9. Dual Fuel Sulfur Dioxide Emission Factor Determination

SO_2 Emission Factor, Dual Fuel	**Value**	**Units**
Gas, 1 ppmv S	0.16610	lb SO_2/mmcf
HHV Scarborough LNG	1007.6	BTU/cf
Gas, 1 ppmv S	0.00016	lb/mmBTU
Heat Rate (40% efficiency)	8533	BTU/kW-hr
Gas, 1 ppmv S	0.0006	g/kW-hr
CA Diesel, 15 ppmw S	0.00003	lb SO_2/lb
HHV AP-42 Table 3.3-1	19300	BTU/lb
CA Diesel, 15 ppmw S	0.00155	lb/mmBTU
Heat Rate (40% efficiency)	8533	BTU/kW-hr
CA Diesel, 15 ppmw S	0.0056	g/kW-hr
~~99.2% gas, 0.8% CA diesel by HI~~	~~0.0007~~	~~g/kW-hr~~

Carrier Activity Profile

An "LNG Carrier Activity Profile" template for operations in Federal Waters was developed in two stages, preliminary and refined. The preliminary profile developed by the air quality consultant with input from BHP was used until September 14, 2006. The preliminary profile yielded a time weighted average load of approximately 12% for Federal Waters operations for a hypothetical 60,000 horsepower (44,742 kW) vessel in operation for 3,120 hours per year (130 berthings, 24 hrs each). The refined profile was provided to BHP on September 14, 2006. The refined profile yields a time weighted average load of approximately 14% for Federal Waters operations for either 33,000 or 44,000 kW vessels in operation for 2,069 or 1,651 hours per year (99 and 65 berthings), respectively.

For the purpose of this comment response, "District Waters", "Federal Waters" and "California Coastal Waters" are defined as follows:

- "District Waters": As defined in VCAPCD rules and regulations, this marine zone extends out to three miles from the Ventura County shoreline.
- "Federal Waters": The marine zone from the three-mile "District Waters" boundary to a 25-mile boundary from the Ventura County shoreline.
- "California Coastal Waters: The marine zone from the 25-mile "Federal Waters" boundary to the "California Coastal Waters" boundary as defined in VCAPCD rules and regulations.

These marine zones and boundaries are depicted on the attached map included with this comment response.

The following assumptions apply to Federal Waters transit (from carrier activity profile):

- 99 berthings/yr, 138 km^3
- 99 berthings/yr x 20.9 hrs = 2,069 hrs/yr @ 14% power (138 km^3)
- 65 berthings/yr, 210 km^3
- 65 berthings/yr x 25.4 hrs = 1,651 hrs/yr @ 14% power (210 km^3)
- Carrier emissions from hoteling allocated to Federal Waters vessels (berthed)
- Carrier emissions from pumping allocated to FSRU stationary source
- Power rating for 10 Ebara cargo pumps (12EC-24 1,700 m3/H @ 470 kW @ 95.25% = 4,477 kW)
- Pumps run at 1,619 m^3/hr each; 16,190 m^3/hr total
- 210 km^3 carrier is 13 hrs pumping, 138 km^3 carrier is 8.5 hrs pumping

The following assumptions apply to California Coastal Waters transit:

- 63 miles from state (turn #3) to federal boundary, one way
- 126 miles from state (turn #3) to federal boundary, each berthing round trip
- Full speed = 20 knots = 23 mph
- Transit time = 5.5 hrs each berthing @ 90% power
- 99 berthings/yr x 5.5 hrs = 545 hrs/yr @ 90% power (138 km^3)
- 65 berthings/yr x 5.5 hrs = 358 hrs/yr @ 90% power (210 km^3)

(see http://www.cabrilloport.ene.com/files/060313/4.03_Marine_Traffic.pdf for carrier route through state waters, beginning at turn #3)

Emission Calculations

Carrier emissions are calculated simply as the product of rating (33 MW or 44 MW), percent load, operating time, and emission factor, with appropriate unit conversions:

- Emissions (total lbs/yr) = Rating (MW) x Load (%) x Time (hrs/yr) x Emission Factor (lb/MW-hr)

- Emissions (average lbs/hr) = Rating (MW) x Load (%) x Emission Factor (lb/MW-hr)

Emission factors expressed in g/kW-hr are converted to lb/MW-hr by multiplying by 1,000 kW/MW and dividing by 453.59 g/lb. The 33.3% adjustment to the Wartsila factors is made by multiplying by four-thirds (4/3). Calculations are shown on the following templates:

- LNG Carrier (138 km^3) California Coastal Waters
- LNG Carrier (210 km^3) California Coastal Waters
- LNG Carrier (138 km^3) Federal Waters
- LNG Carrier (210 km^3) Federal Waters

Tables 10 and 11 summarize carrier emissions through State and Federal Waters, in the safety zone, and berthed to the FSRU. All LNG carrier operations conducted within State and Federal Waters will be in dual fuel (99.2% gas, 0.8% diesel) mode (no 100% fuel oil operation).

Table 10. 138,000 m^3 Capacity LNG Carrier Emissions in Dual Fuel Mode

EMITTENT NAME	138 km^3 / 33,000 kW / 99 Trips				
	California Coastal Waters	Federal Waters	FW Safety Zone	FW Berthed	Total
	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Nitrogen Oxides (as NO_2)	35.69	15.79	1.56	3.73	**56.76**
Reactive Organic Compounds (ROC) as CH_4	10.25	4.54	0.45	1.07	**16.31**
Carbon Monoxide (CO)	25.22	11.16	1.10	2.64	**40.11**
Sulfur Dioxide (SO_2)	0.01	0.01	0.00	0.00	**0.02**
Particulates (as PM_{10})	1.57	0.70	0.07	0.16	**2.50**
Carbon Dioxide (CO_2)	10,563	4,673	460	1,105	**16,801**

Table 11. 210,000 m^3 Capacity LNG Carrier Emissions in Dual Fuel Mode

EMITTENT NAME	210 km^3 / 44,000 kW / 65 Trips				
	California Coastal Waters	Federal Waters	FW Safety Zone	FW Berthed	Total
	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Nitrogen Oxides (as NO_2)	31.25	16.80	1.65	3.97	**53.68**
Reactive Organic Compounds (ROC) as CH_4	8.98	4.83	0.48	1.14	**15.42**
Carbon Monoxide (CO)	22.09	11.87	1.17	2.81	**37.93**
Sulfur Dioxide (SO_2)	0.01	0.01	0.00	0.00	**0.02**
Particulates (as PM_{10})	1.38	0.74	0.07	0.18	**2.37**
Carbon Dioxide (CO_2)	9,251	4,972	490	1,175	**15,888**

Question 3: *Please provide an explanation for the difference between the LNG carrier emissions estimates provided in the March 2006 RDEIR and the estimates provided to EPA in the December 2005 application and subsequent submittals.*

Answer 3:

The higher LNG carrier emissions in the March 2006 RDEIR (Table 4.6-13) are based on AP-42 Table 3.2-2 emission factors for gas engines assuming a heat rate of 9751 BTU/kW-hr (35% efficiency), with a 7% adjustment made for diesel pilot fuel sulfur content and particulate emissions, as shown in Table 12. This yields a NO_X factor of 3.746 g/kW-hr and a CO factor of 2.464 g/kW-hr, both of which are relatively high compared to Wartsila emissions. Carrier activity in the RDEIR estimate was based on 130 berthings/yr, 3120 hrs/yr, 60,000 horsepower (44,742 kW), and 12% average load, which is also higher capacity than the assumptions described in the preceding sections. Thus, this early estimate represented an "upper bound" for

NO_X and CO emissions in particular, and probably overstated carrier emissions of NO_X and CO. In response to comments BHP has refined this analysis since the RDEIR was prepared.

Table 12. March 2006 RDEIR LNG Carrier Emissions

Gas, AP-42, Table 3.2-2 (RDEIR)	lb/mmBTU	BTU/kW-hr	g/kW-hr	g/BHP-hr	tons/yr
Nitrogen Oxides (as NO_2)	0.847	9751	3.746	2.794	69.2
Reactive Hydrocarbons (ROC) as CH_4	0.118	9751	0.522	0.389	9.6
Carbon Monoxide (CO)	0.557	9751	2.464	1.837	45.5
Sulfur Dioxide (SO_2)	1.78E-04	9751	0.0008	0.0006	0.01
Particulates (as PM_{10})	0.010744	9751	0.048	0.035	0.9
Carbon Dioxide (CO_2)	110	9751	487	363	8984

Question 4: *Please describe the activities for which each vessel will be used and provide current calculations for the emissions from those vessels.*

Answer 4:

Cabrillo Port will require two tug/supply vessels and one crew boat during operations. The LNG carriers are anticipated to be available to the Project in either size of $210{,}000M^3$ or $138{,}000M^3$. The LNG carriers will not be able to deliver more LNG than allowed by permit, so deliveries by the larger sized vessel would only occur, on average, 1.2 times/week, whereas deliveries by the smaller sized vessel would occur 1.9 times/week. Clearly there could be a combination of LNG carriers of these two sizes, but in any case Cabrillo Port could never exceed the permitted thresholds of gas delivery. Consequently, the smaller sized carrier is the worst case scenario and the emissions are based upon the maximum marine vessel transits that support the $138{,}000M^3$ carrier.

BHP will utilize three dedicated support vessels for the project: two tug/supply vessels and one crew boat. The tug will also serve as a supply vessel for the FSRU. Controlled modern diesel engines will be used in the Cabrillo Port tugs and the crew boat. All three support vessels periodically visit shore (Port Hueneme).

BHP initially proposed to utilize natural gas fired engines with the fuel being stored as LNG (CNG is too bulky for use in vessels such as these). The gas fired tugs were proposed in order to decrease emissions as compared to conventional diesel fired tugs. Numerous parties subsequently expressed discomfort regarding the presence of LNG in the vessel holds during port visits. In order to find a means of retaining the emissions benefits garnered by using natural gas fired vessels while also trying to resolve these concerns, BHP turned to its marine engineers and the engine manufacturers to see if another solution was viable. They had previously determined that the space needs and complexity of a gas fired vessel made the use of tailpipe controls unfeasible. However they determined that a conventional diesel vessel can be controlled using catalytic technology. While we are unaware of any controlled tugs or crew boats operating off the California coast, we understand that there are controlled tugs and crew boats operating elsewhere in the world. By installing a broad suite of controls on these engines BHP can ensure that the emissions of all pollutants but sulfur dioxide (i.e., NOx, CO, VOC and PM_{10}) will stay equal to, or possibly less than, the emissions of natural gas fired vessels. SO_2 emissions will increase slightly notwithstanding the use of ultra-low sulfur California diesel. By introducing controlled diesel engines to heavy duty marine vessels in Southern California BHP will set an important precedent that will ultimately result in lower marine emissions throughout the region as the marine industry recognizes that the technology is feasible.

Detailed descriptions of each of these vessels follow.

Tug/Supply Vessels

Tug/supply vessels (hereafter referred to as the tugs), provide mooring assistance to the LNG carriers upon arrival to the FSRU. The pilot onboard the FSRU boards one of the tugs, and meets the LNG carrier about three miles out from the FSRU. The pilot boards the LNG carrier and guides it into the FSRU, as assisted by both the tugs. Working together the tugs push the LNG carrier toward the FSRU, and hold it in place while the mooring lines are secured. Once secured and the LNG cargo unloading is underway, the tugs return to patrolling the safety zone, which is their duty while not engaged in berthing assistance.

The two tugs will be purpose built vessels dedicated to Cabrillo Port. They will utilize a combination of engines totally approximately 15,000 BHP running on California diesel. The tugs will alternate port calls with at least one tug always located at the FSRU. One tug will make a round trip to port each week for supplies and refueling. Two tugs will always be present during carrier berthing and offloading.

Specific engines have not been identified for the Cabrillo Port tugs. Wartsila has proposed the use of two (2) 4L32DF (1,875 BHP each) and three (3) 8L32DF (3,750 BHP each) engine-generators. However, because BHP is not sure of what diesel engine manufacturer it will use for the purpose built tugs, BHP utilized the nonroad engine Tier 2 emission factors from 40 CFR 89.1 12 as the basis for its emission factors in the emissions spreadsheets. The actual Tier 2 standards applicable to marine engines appear in 40 CFR 94.8. The nonroad engine Tier 2 standards were used because they are identified in relation to engine power rating while the marine emission standards are identified in relation to cylinder displacement. BHP concluded that it was clearer to refer to the nonroad standards. The difference in emission rate between the two standards will be insignificant in light of the controls and the high control efficiency being proposed.

BHP consulted with control manufacturers regarding likely levels of control that could be achieved for the tug and crew boat diesel engines. Munters, a leading manufacturer of SCR controls for marine applications, stated that BHP should expect NOx control efficiencies of between 90% and 95%. This level of control is consistent with that claimed by Wartsila in its literature where they state that reduction efficiencies of 85% to 95% should be expected. Munters' and Wartsila's promotional materials are included with this letter. Based on these manufacturer representations, BHP conservatively assumed a NOx control efficiency of 80% in developing the emission inventories, which results in 14% lower NOx emissions than the originally proposed gas-fired engines without controls.

Based on experience with similar controls on diesel engines, BHP anticipates that it can reliably achieve reductions of CO and ROC of 70% and 40%, respectively with an oxidation catalyst. BHP will also utilize particulate traps on the engines to minimize particulate emissions.

In your letter you express a concern that the emission factors used in calculating emissions may underestimate emission because the are associated with high load conditions and the load profiles developed by BHP's marine engineers indicated frequent low load operations. Unlike conventional vessels where there are one or two propulsion engines that directly power the propulsion mechanism, a diesel-electric system consists of multiple engines that operate according to load requirements. This system results in substantially lower emissions because each engine operates in its optimal range, as well as offering the benefit of redundancy. As noted above, one possible configuration for a tug servicing Cabrillo Port would be to have two (2) 4L32DF and three (3) 8L32DF engine-generators. With this type of configuration, in each power step, the engines are running at or near maximum load for high efficiency and low emissions. Several possible power combinations are shown in Table 13 to demonstrate how this type of vessel meets its power needs. Since the engines are operated at the upper range of their power curve, the low emission rates of 1.12 g/kW-hr NO_X and 1.04 g/kW-hr CO will be achieved. Thus, these emission factors correctly represent the anticipated emission rates as the tug is not run at a fraction of the any engine's rating.

Table 13. Engine-Generator Combinations

Conceptual Tug Supply Boat Engine-Generator Combinations						
Power Scenario	**Percent of Total Propulsion Power**	**4L32DF #1**	**4L32DF #2**	**8L32DF #3**	**8L32DF #4**	**8L32DF #5**
A	12.5%	♦				
B	25.0%			♦		
C	37.5%		♦	♦		
D	50.0%			♦	♦	
E	62.5%	♦		♦	♦	
F	75.0%			♦	♦	♦
G	87.5%		♦	♦	♦	♦
H	100.0%	♦	♦	♦	♦	♦

As noted above, the Wartsila engines are used by means of example, but no final decision has been made on the particular engine manufacturer. For this reason, controlled Tier 2 factors were used to conservatively estimate emissions. Detailed support vessel emission calculations are included as an attachment to this letter indicating all emission factors, assumptions and parameters employed. Please also note that we have eliminated the tug/supply boat auxiliary generator emissions from these emission calculations, since, as outlined above, the design will not include separate generator engines.

Crew Boat

A crew boat will meet the LNG carrier upon its arrival at the FSRU for the purpose of a fresh crew for the carrier. The crew boat will carry the replacement crew members for the LNG carrier, in addition to port officials and supplies. Upon arrival at the LNG carrier, crew and officials will board the carrier and receive briefings and paperwork from the transition crew. After depositing these persons and supplies, the crew boat will engage in patrol duties around the safety zone while the LNG carrier is assisted to its berthing alongside the FSRU by the tug / supply vessels. Once the tug/supply vessels have completed berthing assistance and the LNG carrier is unloading its cargo, the crew boat will pick up the returning crew from the carrier and depart for shore. Once the LNG carrier has completed it's unloading process, the tug / supply vessels – which have been patrolling the safety zone – assist with unberthing the carrier, and the crew boat returns to conduct patrol duties in their place. The crew boat may also bring additional supplies or materials as necessary to the carrier before its departure.

The single purpose built crew boat will also be diesel fired with a full suite of emission controls (SCR, oxidation catalyst and particulate trap). The crew boat will make two trips to port for every visit by a carrier. Because the maximum number of carriers that could call on the FSRU per year is 99, emissions were calculated based on 198 round trips to the FSRU by the crew boat each year. The crew boat is expected to employ two 75 BHP auxiliary generator engines and either two 750 BHP or three 500 BHP propulsion engines. All four (or five) engines would be vented to the control devices.

Note that LNG carriers sized at 210,000M^3 may also be utilized, resulting in only 65 visits per year, and 130 crew boat trips.

In response to comments regarding facility security, BHP has agreed as a mitigation measure to utilize the crew boat to patrol the FSRU safety zone while the two tugs are engaged in docking an LNG carrier and again at unberthing. This results in increased crew boat operation while in Federal Waters as compared to what was identified in the December 2005 application. The crew boat is dual purposed, and BHP has combined patrol duties and LNG carrier crew changes in the least amount of transits to further mitigate air emissions to the greatest extent possible. Predicted operations in patrol mode are identified in the attached emissions spreadsheet identified as "Crew Boat Activity Summary."

Vessel Emissions In California Coastal Waters

At EPA's request, we have also included in the Federal Waters spreadsheets calculations of the vessel emissions outside Federal Waters but within what CARB has defined as "California Coastal Waters." To help visualize the relationship between the boundary of Federal Waters and California Coastal Waters, we have included a map showing the delineation of each zone. For clarity, the map does not show the 3-mile District water zones around Anacapa and San Nicolas Islands. The exclusive fuel used by the LNG carriers while operating in California Coastal Waters (including in Federal Waters) is natural gas. No other project vessels (i.e., the crew boat and the tug/supply boats) operate outside of Federal Waters.

We are including information concerning the carrier "to and fro" emissions as a courtesy to EPA. We believe that the carrier to and fro and hoteling emissions have no relevance to the stationary source permitting exercise with which EPA is tasked. Ventura County APCD clearly stated in its June 18, 2004 letter from Michael Villegas to Gerardo Rios that vessel hoteling and to and fro emissions outside of District waters should not be included in the stationary source emission inventory. This is standard air district procedure and is not an interpretation unique to this project. Therefore, as the permit grants authority to construct the stationary source, we are frankly perplexed by these EPA questions. Nonetheless, we have attempted to be responsive and so have included these emissions in the worksheets. Please note that the worksheets that present the California Coastal Waters emissions calculations for the two sizes of carriers (Table FW 9 and Table FW 10) represent the emissions between the outer edge of Federal Waters and inside the outer boundary of California Coastal Waters.

I trust that this letter fully and completely answers EPA's questions. Please contact me immediately if this is not the case.

Sincerely,

Thomas R. Wood

cc: Renee Klimczak
Rick Abel
Margaret Alkon
Joe Lapka

Attachments